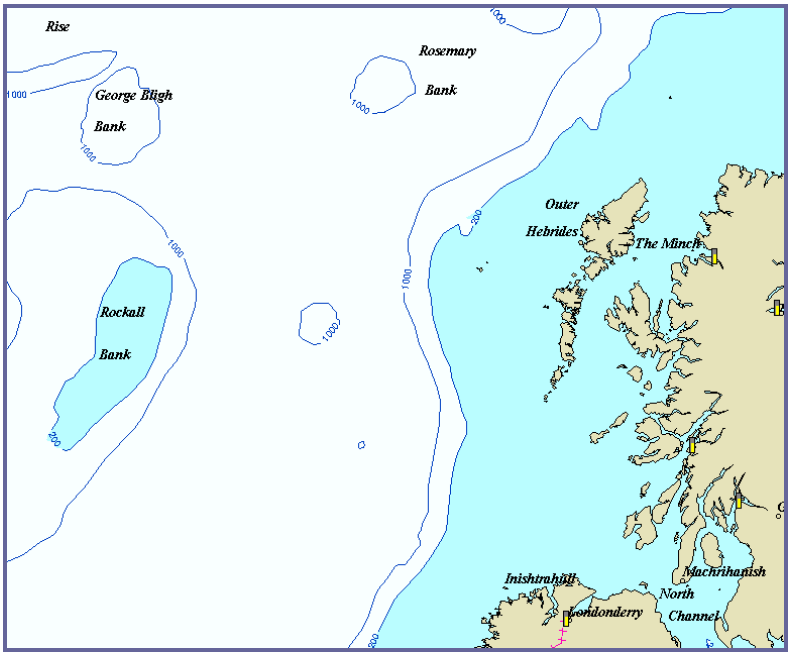
FSS Survey Series: 2011/01

Blue Whiting Acoustic Survey Cruise Report

March 28- April 16, 2011



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1 Introduction

Acoustic surveys on blue whiting (*Micromesistius poutassou*) spawning aggregations in the northeast Atlantic have been carried out by the Institute of Marine Research (IMR) Norway since the early 1970s. In the early 1980s a coordinated acoustic survey approach was adopted, with both Russia and Norway participating to estimate the size of this migratory stock within the main spawning grounds to the west of Ireland and Britain. Since 2004, an International coordinated survey program has expanded to include vessels from the EU (Ireland and the Netherlands) and the Faroes.

Due to the highly migratory nature of the stock a large geographical area has to be surveyed. Spawning takes place from January through to April along the shelf break from the southern Porcupine Bank area northwards to the Faroe Shetland Ridge including offshore areas as the Rosemary, Hatton and Rockall Banks. Peak spawning occurs from early March to mid April and acoustic surveys are timed to occur during this phase. To facilitate a more coordinated spatio-temporal approach to the survey participating countries meet annually to discuss survey methods and define target areas at the ICES led Working Group of Northern Pelagic Ecosystem Surveys (WGNAPES).

Data from the annual spawning stock abundance survey (March/April, western waters), juvenile surveys (May, Norwegian Sea and January-March, Barents Sea trawl survey) and commercial landings data are presented annually at the ICES Working Group of Widely Distributed Stocks (WGWDS). Ultimately, combined data inputs into the management and catch advice for this international cross boundary stock.

The 2011 survey was part of an International collaborative survey using the vessels RV *Celtic Explorer* (Ireland), RV *Fridtjof Nansen* (Russia), RV *Tridens* (Netherlands) and the RV *Magnus Heinason* (Faroes) and the RV *G.O. Sars* (Norway). The total combined area coverage extended from the Faroe Islands in the north (60.30°N) to south of Ireland (52°N), with east -west extension from 6°-17° W.

International survey participants meet shortly after the survey to present data and produce a combined relative abundance and biomass index the blue whiting spawning stock in western waters. The combined survey report is presented annually at the WGNAPES meeting held in August and made available to the WGWDS assessment group.

2 Materials and Methods

2.1 Scientific Personnel

Name	Institute	Capacity
Ryan Saunders	FSS	SIC
Eugene Mullins	FSS	Acoustics
Graham Johnston	FSS	Acoustics
Robert Bunn	FSS	Acoustics
Grainne Ni Chonicuir	FSS	Biologist
Jan Pederson	DT Aqua	Biologist
Shay Fennelly	Ind	MMO

2.2 Survey Plan

2.2.1 Survey objectives

The primary survey objectives are listed below:

- Collect acoustic data on spawning and post spawning aggregations of blue whiting (*Micromesistius poutassou*) along the northern migration pathway from key spawning areas in target areas 1 and 2b (WGNAPES defined). Repeat the survey cruise track in the opposite direction
- Determine an age stratified estimate of relative abundance and biomass of blue whiting for both survey replicates within the survey area
- Collect biological samples from directed trawling on fish echotraces to determine age structure and maturity state of survey stock for individual survey replicates
- Collect physical oceanography data from vertical profiles from a deployed sensor array

2.2.2 Survey design and area coverage

The surveys covered the core spawning area of blue whiting to the west of Scotland and the Western Isles (Figure 1). Coverage extended from the shelf slopes (250m) westward into the Rockall Trough. The survey was carried out in continuity from north to south (Survey 1) and from south to north (Survey 2).

Transect design and effort allocation was pre-agreed for each vessel at the last WGNAPES using a repeat survey methodology in 2011. A parallel transect design was used to allow transect interlacing in co-surveyed target areas (east-west orientation). Offshore, transects extended to the 14°W. Transect spacing was set at 30nmi for individual vessels and maintained throughout the survey.

In total, the Irish survey covered 33,900nmi² using 1,778nmi of transects (Survey 1: 889nmi & Survey 2: 889nmi). Survey design and methodology adheres to the methods laid out in the WGNAPES acoustic survey manual.

2.3 Equipment and system details and specifications

2.3.1 Acoustic array

Equipment settings for the acoustic equipment are based on established settings employed on previous surveys (O'Donnell *et al.,* 2004) as shown in Table 1.

Acoustic data were collected using the Simrad ER60 scientific echosounder. A Simrad ES-38B (38 KHz) split-beam transducer is mounted within the vessels drop keel and lowered to

the working depth of 3.3m below the vessels hull or 8.8m below the sea surface. Three other operating frequencies were used during the survey (18, 120 and 200kHz) for trace recognition purposes, with the 38kHz data used solely to generate the abundance estimate.

While on track the vessel is normally propelled using DC twin electric motor propulsion system with power supplied from 1 main diesel engine, so in effect providing "silent cruising" as compared to normal operations (Anon, 2002). Cruising speed is maintained at a maximum of 10Kts (knots) where possible. During fishing operations normal 2 engine operations were employed to provide sufficient power to tow the net.

2.3.2 Calibration of acoustic equipment

The ER60 was calibrated in outside Stornaway Harbour on March 27 at the start of the survey and again in Donegal Bay at the end. The results from the first calibration are shown in Table 1.

2.3.3 Inter-vessel calibration

Inter-vessel acoustic calibrations are carried out when participant vessels are working within the same general area and time and weather conditions allow for an exercise to be carried out. The procedure follows the methods described by Simmonds & MacLennan 2007.

2.3.4 Acoustic data acquisition

Acoustic data were observed and recorded onto the hard-drive of the processing unit using the equipment settings from previous surveys (Table 1). The "RAW files" were logged via a continuous Ethernet connection as "EK5" files to the vessels server and the ER60 hard drive as a backup in the event of data loss. In addition, as a further back up a hard copy was stored on an external HDD and copied to DVD. Sonar Data's Echoview® Echolog (Version 4.8) live viewer was used to display the echogram during data collection to allow the scientists to scroll through echograms noting the locations and depths of fish shoals. A member of the scientific crew monitored the equipment continually. Time and location (GPS position) data was recorded for each transect within each target area. This log was used to monitor the time spent off track during fishing operations and hydrographic stations plus any other important observations.

2.3.5 Echogram scrutinisation

Acoustic data was backed up onto the vessels server every 24 hrs and scrutinised using Echoview.

The "EK5" files were imported into Echoview for post-processing. The echograms were divided into transects. Echo integration was performed on regions defined by enclosing selecting marks or scatter that belonged to one of the target species categories. The echograms were analysed at a threshold of -70 dB and where necessary plankton were filtered out by thresholding at –65 dB or lower.

Echograms were scrutinised into one of the following categories:

a). Blue whiting
b). Mesopelagic fish
c). Plankton
d). Plankton and mesopelagic fish
e). Pelagic fish

Selection criteria are based primarily on trawl data but also on known habitat preference and target strength (TS) information.

2.3.6 Biological sampling

A single pelagic midwater trawl with the dimensions of 70m in length (LOA) and a fishing circle of 768m was employed during the survey (Figure 10). Mesh size in the wings was 12.5m through to 20mm in the cod-end. The net was fished with a vertical mouth opening of approximately 50m and was observed using a cable linked "BEL Reeson" netsonde (50 kHz).

The net was also fitted with a Scanmar depth sensor. Spread between the trawl doors was monitored using Scanmar distance sensors, all sensors being configured and viewed through a Scanmar Scanbas system.

All components of the catch from the trawl hauls were sorted and weighed; fish and other taxa were identified to species level. Fish samples were divided into species composition by weight. Species other than the blue whiting were weighed as a component of the catch. Age, length, weight, sex, stomach fullness and maturity data were recorded for individual blue whiting within a random 50 fish sample from each trawl haul with a further 100 random length and weight measurements were also taken. All blue whiting were aged onboard. The appropriate raising factors were calculated and applied to provide length frequency compositions for the bulk of each haul.

Decisions to fish on particular echo-traces were largely subjective and an attempt was made to target marks in all areas of concentration not just high density shoals. No bottom trawl gear was used during this survey.

2.3.7 Oceanographic data collection

Oceanographic stations were carried out during the survey at predetermined locations along the track (Figure 5). Data on temperature, depth and salinity were collected using a Seabird 911 sampler from 1m subsurface to 1000m where depth allowed or to within 10m of the bottom on shelf slopes.

2.4 Analysis methods

2.4.1 Echogram partitioning and abundance estimates

The recordings of area back scattering strength (NASC) per nautical mile were averaged over one nautical mile, and the allocation of area backscattering strengths to species was made by comparison of the appearance of the echo recordings to trawl catches.

The allocation of NASC (Nautical Area Scattering Coefficient) values to blue whiting and other acoustic targets was based on the composition of the trawl catches and the appearance of the echotraces. To estimate the abundance, the allocated NASC values were averaged for ICES statistical rectangles (1° latitude by 2° longitude). For each statistical area, the unit area density of fish (ρ_A) in number per square nautical mile ($N*nm^{-2}$) was calculated using standard equations (Foote et al. 1987, Toresen *et al*. 1998).

For blue whiting a TS= 21.8 log(L) – 72.8 dB was applied.

To estimate the total abundance of fish, the unit area abundance for each statistical rectangle was multiplied by the number of square nautical miles in each statistical square and then summed for all statistical rectangles within defined sub areas and for the total area. Biomass estimation was calculated by multiplying abundance in numbers by the average weight of the fish in each statistical rectangle and then sum of all squares within defined sub areas and the total area.

During the 2010 international survey planning group meeting (WGNAPES) it was decided that each participant vessel should cover their assigned track twice in opposing directions. Each survey should be treated as an individual standalone survey and the same track should be utilised for each replicate. The reasoning behind this change in design was to try and estimate the degree of variability associated with active stock migration during the survey. The scrutinized acoustic data, biological data and oceanographic measurements from each of the Irish replicate surveys were uploaded to the WGNAPES online database as individual surveys for ease of data handling.

3 Results

3.1 Blue whiting abundance and distribution

To take account of the dual survey approached adopted by WGNAPES in 2011 abundance estimates for each replicate are presented as Survey 1 (north to south) and Survey 2 (south to north).

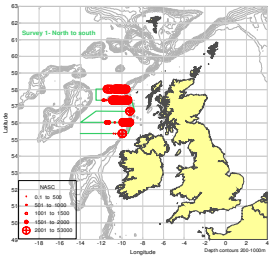
-Survey 1 was carried out from north to south from 28 March - 02 April (5 days)
-5 day weather induced time lag
-Survey 2 was carried out from south to north from 07 March - 11 April (4 days)

A total of 11 directed trawls (Survey 1: 7 & Survey 2: 4) were carried out during the survey (Figure 1, Table 2). All trawls contained blue whiting and 9 hauls contained over 52% blue whiting by weight. Several high density mackerel registrations were encountered on the shelf slopes between 220-260m and were most abundant between 55-58ºN during survey 1.

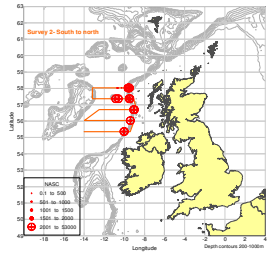
3.1.2 Blue whiting biomass and abundance

A full breakdown of the survey stock structure is presented by distribution, age, length, biomass, abundance and area in Tables 3, 4, 5a, b & 7 and Figures 2 & 4.

Survey 1 Target Area	TSN (mil)	SSN (mil)	TSB ('000s t)	SSB ('000s t)
Hebrides (1)	9,057.1	8,515.1	1,394.7	1,373.5
Rockall (2b)	0.0	0.0	0.0	0.0
Total	**9,057.1**	**8,515.1**	**1,394.7**	**1,373.5**



Survey 2 Target Area	TSN (mil)	SSN (mil)	TSB ('000s t)	SSB ('000s t)
Hebrides (1)	1,590.5	1,561.6	234.6	233.6
Rockall (2b)	0.0	0.0	0.0	0.0
Total	**1,590.5**	**1,561.6**	**234.6**	**233.6**



Biomass and abundance estimates between survey replicates show a difference of over 82% in terms of both weight and numbers. The difference between the successive estimates can be attributed to the time lag and the progression of stock migration. The second replicate occurred at the end of the spawning period at a time when most of the spawning stock had already migrated further northwards outside of the survey area covered by the Celtic Explorer. The time difference between replicates was 5 days and the 2011 survey was 9 days later than in 2010 and previous years.

3.1.3 Blue whiting distribution

No blue whiting were observed west of the 12ºW (Rockall) during either survey replicate and the bulk of the survey stock was located close to the shelf break south of 57ºN within the Hebrides target area (Figure 2). During both survey replicates high density schools were observed around the Aton Dhorn seamount, with the greatest abundance observed during survey 1. South of 57ºN, few schools were observed in open water (Rockall Trough) during survey 1 and no schools were observed in this area during survey 2.

The pattern of distribution observed is consistent with previous years. During the 2009-2010 surveys over 80% of the stock located within the Hebrides core area.

The Rockall subarea was not covered as originally planned. Commercial fishing activity by Russian and Norwegian vessel was reported in this area at the start survey 1. After survey 1 poor weather forced the Explorer to shelter for 5 days by which point the commercial fishery in southwest Rockall had ceased, therefore reallocating survey effort to Rockall at this point would have been futile.

3.1.4 Blue whiting stock structure

During the survey 550 fish were aged (Survey 1: n=350, Survey 2: n=200) with length, weight, sex, maturity and stomach fullness data were recorded. A further 1,100 fish were measured and weighed. Analyses of age samples were found to contain individuals of 1 to 12-years old (Figure 4).

The age structure between survey replicates was dominated by the 3 strongest year classes in the stock namely the 8, 9 and 7-year old fish respectively. Together these dominant year classes represented 76% of the TSB and 69% of the TSN from Survey 1 and 66% of the TSB and 58% of the TSN from Survey 2.

The differences in age profile between successive survey replicates for non dominant year classes is not easily explained but may be in part attributed to the level of age sampling undertaken and also due to the effects of migration within components of the stock. The contribution of residual stock components on the main spawning grounds will play a part in the age structure of stock during post spawning assessment.

3.2 Oceanography

Overall 32 CTD casts were carried out during the survey (Figure 5). Open water stations were conducted to a maximum of 1,000m. Horizontal profiles of temperature and salinity from 10m subsurface to 600m are shown in Figures 6-9.

3.2 Inter-vessel calibration

No inter vessel calibration was carried out due to time constraints brought on by prolonged poor weather conditions midway through the survey.

4 Discussion and Conclusions

4.1 Discussion

Overall, the survey covered the core grounds in replicate as planned. Poor weather conditions resulted in 5 days of lost survey time which meant that the Rockall subarea could not be covered as planned.

Communication between participant vessels was good in part, although changes to planned coverage was not effectively discussed or communicated before being undertaken. Had this taken place then gaps in area coverage, namely the Rockall sub area, could have been filled using the reallocation of effort from other participants.

The abundance estimates determined from replicates vary greatly and this can be directly attributed to timing. As the survey was later in 2011 than in 2010 it was expected that the bulk of the stock would be located further north. Added to this was the temporal gap between successive replicates in 2011. It was evident from the first coverage that the stock was distributed in the northern reaches of the survey area. Five days later when the second replicate was undertaken (from south to north) the bulk of the fish had already migrated northwards out of the survey area and this was reflected in the resultant abundance estimate (0.23mt).

4.2 Conclusions

As this survey forms part of larger cooperative survey approach it is difficult to take the results from a single survey in isolation as an indicator of the state of the stock. The results from the international survey are pending but first indications are that the stock was covered without gaps in core areas thus providing a more precise estimate than occurred in 2010.

During the 2011 survey a change in survey approach was undertaken to avoid the problems encountered in 2010. The use of survey replicates was carefully considered during the survey design so as not to impact on the integrity of the international time series. However, time loses due to poor weather conditions are unavoidable and present a constant problem to achieving planned goals. One of the Norwegian pelagic reference fleet was fishing on Rockall spawning aggregations and collected data using a calibrated echosounder. However, due to the sporadic nature in which the data was collected it will not be possible to produce a reliable quantitative estimate in line with survey data. Comparing echograms and NASC values of schools will be a useful qualitative exercise during WGNAPES.

The results from this survey, during both replicates, show the stock within the Hebrides core area remains dominated by 3 strong year classes as in previous survey carried out in this area. The contribution of younger individuals most notably the 3 and 4 year old fish is difficult to explain as poor recruitment has dominated this stock for a number of years. The ecosystem survey in the Norwegian Sea has been used as an indicator for emerging blue whiting year classes but since 2004 but has failed to identify a firm signal of recruitment. The International spawning stock survey itself cannot be used as a recruitment predictor due to the nature of the survey and the migration of the adult stock to the spawning grounds. Results from the International survey in 2010 showed a strong signal of 2 year old fish in the Shetland/Faroe region which could account for the higher than expected proportion of 3 year old fish observed during survey 1.

Acknowledgements

We would like to express our thanks and gratitude to Dennis Rowan (Captain) and crew of the Celtic Explorer for their good will and professionalism during the survey.

Our special thanks also go to our visiting scientist Jan Pederson (DTU Aqua, Denmark) for his help and hard work during the survey.

References/Bibliography

Anon. (Monstad et al), 1982. Report of the International acoustic survey on blue whiting in the Norwegian Sea, July/August 1982. ICES, Doc.CM. 1982/ H.5.

Anon (2002) Underwater noise of research vessels. Review and recommendations. 2002. ICES No. 209.

Dalen, J. and Nakken, O. (1983) "On the application of the echo integration method" ICES CM 1983/B:19

Foote, K.G. (1987). Fish target strengths for use in echo integrator surveys. *J. Acoust. Soc. Am.* 82: 981-987

Foote, K.G., Knudsen, H.P., Vestnes, G., MacLennan, D.N. and Simmonds, E.J. (1987). Calibration of acoustic instruments for fish density estimation: a practical guide. *Int. Coun. Explor. Sea. Coop. Res. Rep.* 144: 57 pp

Hatun H., Payne, M. and Jacobsen, J.A. (2009). The North Atlantic subpolar gyre regulates the spawning distribution of blue whiting (*Micromesistius poutassou*). Can. J. Aquat. Sci. 66: 759-770.

MacLennan, D and Simmons, J. 2005. Fisheries Acoustics. Theory and Practice. Second edition. Blackwell publishing. 325-328pp.

O'Donnell, C., Mullins, E., Monstad, T., Macualay, G., Power, G. and Ullgren, J. 2004 .Blue Whiting Acoustic Survey Cruise Report. Marine Institute, Ireland. Survey series 04:01

O'Donnell, C., Mullins, E., Johnston, G., Saunders, R., Lyons., K., Beattie, S., McCann, K. and Pihl., N.J. 2010. Blue whiting Acoustic Survey cruise Report. Marine Institute, Ireland. Survey series 10:01

Simmonds, J. and Mac Lennan D. 2007. Fisheries acoustics, theory and practice. Second edition. Blackwell publishing

Toresen, R., Gjøsæter, H. and Barros de, P. 1998. The acoustic method as used in the abundance estimation of capelin (*Mallotus villosus* Müller) and herring (*Clupea harengus* Linné) in the Barents Sea. Fisheries Research, 34: 27–37.

Table 1. Survey settings and calibration report for the Simrad ER60 echosounder. Blue whiting survey, March-April 2011.

Echo Sounder System Calibration

Vessel :	R/V Celtic Explorer	Date :	27/03/2011
Echo sounder :	ER60 PC	Locality :	Stornaway
Type of Sphere :	WC-38,1	TS_{Sphere}: (Corrected for soundvelocity or t,S)	-33.50 dB
		Depth(Sea floor) :	32 m

Calibration Version 2.1.0.11

Comments:
CE11005.BWAS.Stornaway. 27.03.11. 38 khz

Reference Target:

TS	-33.50 dB	Min. Distance	10.00 m
TS Deviation	5.0 dB	Max. Distance	20.00 m

Transducer: ES38B Serial No. 30227

Frequency	38000 Hz	Beamtype	Split
Gain	25.90 dB	Two Way Beam Angle	-20.6 dB
Athw. Angle Sens.	21.90	Along. Angle Sens.	21.90
Athw. Beam Angle	7.15 deg	Along. Beam Angle	7.08 deg
Athw. Offset Angle	- 0.03 deg	Along. Offset Angl	-0.07 deg
SaCorrection	-0.64 dB	Depth	5.0 m

Transceiver: GPT 38 kHz 009072033933 1 ES38B

Pulse Duration	1.024 ms	Sample Interval	0.190 m
Power	2000 W	Receiver Bandwidth	2.43 kHz

Sounder Type:
ER60 Version 2.2.0

TS Detection:

Min. Value	-50.0 dB	Min. Spacing	100 %
Max. Beam Comp.	6.0 dB	Min. Echolength	80 %
Max. Phase Dev.	8.0	Max. Echolength	180 %

Environment:

Absorption Coeff.	10.1 dB/km	Sound Velocity	1483.7 m/s

Beam Model results:

Transducer Gain =	25.92 dB	SaCorrection =	-0.65 dB
Athw. Beam Angle =	6.95 deg	Along. Beam Angle =	6.91 deg
Athw. Offset Angle =	-0.03 deg	Along. Offset Angle=	-0.08 deg

Data deviation from beam model:
RMS = 0.13 dB
Max = 0.27 dB No. = 161 Athw. = 4.1 deg Along = 2.8deg
Min = -0.35 dB No. = 228 Athw. = -3.2 deg Along = 4.0 deg

Data deviation from polynomial model:
RMS = 0.06 dB
Max = 0.15 dB No. = 234 Athw. = -1.9 deg Along = 3.8 deg
Min = -0.18 dB No. = 50 Athw. = -4.1 deg Along = -2.2 deg

Comments :

Wind Force : **Wind Direction :**
Raw Data File: \\Expfileclstr\ER-60_Data\BWAS_2011\RAW ER60 Files\Calibration\BWAS_Mar_2011
Calibration File: \\Expfileclstr\ER-60_Data\ER-60\Calibrations_2011\BWAS 2011\38 KHZ

Table 2. Catch composition, time and location of trawl hauls. Top panel Survey 1, bottom panel Survey 2. Blue whiting survey, March-April 2011.

No.	Date	Lat. N	Lon. W	Time	Bottom (m)	Target (m)	Bulk Catch (Kg)	Sampled (Kg)	Blue Whiting %	Mackerel %	Meso %	Herring %	Others %
1	28/03/2011	58.1.643	10.0.03	06:51	1914	400	200.0	162.7	95.7	3.4	0.7	0.0	0.2
2	29/03/2011	57.22.03	11.44.84	02:43	1900	385-405	2,500.0	129.8	98.5	1.4	0.1	0.0	0.0
3	29/03/2011	57.21.95	10.41.64	08:45	2000	350-500	1,500.0	189.8	87.0	12.8	0.2	0.0	0.0
4	29/03/2011	57.21.962	9.26.135	16:22	500	300-500	4,000.0	156.2	24.3	75.6	0.1	0.0	0.0
5	30/03/2011	56.41.98	9.17.235	02:45	1150	400-430	300.0	153.1	52.0	47.7	0.1	0.0	0.1
6	31/03/2011	56.1.919	9.16.00	21:24	600	400	300.0	140.6	89.3	4.8	0.0	0.0	5.9
7	01/04/2011	55.23.794	9.56.923	19:08	620	500	300.0	224.0	46.2	53.7	0.1	0.0	0.0

No.	Date	Lat. N	Lon. W	Time	Bottom (m)	Target (m)	Bulk Catch (Kg)	Sampled (Kg)	Blue Whiting %	Mackerel %	Meso %	Herring %	Others %
1	07/04/2011	55.23.26	9.59.96	17:05	750	400	5,000	212.8	99.9	0.1	0.0	0.0	0.0
2	09/04/2011	56.41.988	9.1.314	19:13	800	400	600.0	165.6	97.4	1.5	1.1	0.0	0.0
3	10/04/2011	57.19.483	9.29.094	04:07	660	430	206.1	206.1	94.7	0.5	1.3	0.0	0.5
4	11/04/2011	58.01.534	9.34.52	12:25	500	450	400.0	123.3	87.6	0.0	10.4	0.0	2.0

Note: “Others” was used to represent fish and non-fish species occurring in the catch see Table 6.

Table 3. Breakdown of abundance estimate by survey and sub area (Target area 1: Hebrides, Target area 2: Rockall). Survey 1: North to south, Survey 2: South to north. Blue whiting survey, March-April 2011.

Survey 1	NASC	Area	Trawl	length	Density coeff.	Abundance	weight	Biomass
Rectangle	$m^2/n.m^2$	$n.mile^2$	haul(s) #	cm	$1.488 * 10^6 * L^{-2.18}$	$N * 10^6$	gram	1000 tonnes
5508	1477.5	749	7	31.40	811.51	898.04	157.1	141.08
5510	191.6	257	7	31.40	811.51	39.96	157.1	6.28
5608	1021.0	1085	5&6	30.90	840.41	930.98	148.4	138.16
5610	707.9	75	5&6	30.90	840.41	44.62	148.4	6.62
5708	1426.1	1045	4	25.60	1266.60	1887.57	97.7	184.42
5710	2166.3	1860	2&3	32.00	778.71	3137.61	178.8	561.00
5808	2095.6	306	1	32.40	757.91	486.02	168.6	81.94
5810	2652.4	812	1	32.40	757.91	1632.34	168.6	275.21
Target Area 1					**Sub area total**	**9057.1**		**1394.7**
5512	0.0	-	-	-	-	0.00	-	0.00
5612	0.0	-	-	-	-	0.00	-	0.00
5712	0.0	-	-	-	-	0.00	-	0.00
5812	0.0	-	-	-	-	0.00	-	0.00
Target Area 2b					**Sub area total**	**0.0**		**0.0**
					Grand total	**9057.1**		**1394.7**

Survey 2	NASC	Area	Trawl	length	Density coeff.	Abundance	weight	Biomass
Rectangle	$m^2/n.m^2$	$n.mile^2$	haul(s) #	cm	$1.488 * 10^6 * L^{-2.18}$	$N * 10^6$	gram	1000 tonnes
5508	74.6	294	1	31.00	834.52	18.31	151.2	2.77
5510	2574.9	175	1	31.00	834.52	376.04	151.2	56.86
5608	1630.9	300	2	28.60	994.78	486.70	124.3	60.50
5708	1599.8	420	3	31.70	794.87	534.08	161.9	86.47
5710	1089.3	30	3	31.70	794.87	25.98	161.9	4.21
5808	1312.7	140	4	31.50	805.91	148.11	159.2	23.58
5810	158.1	10	4	31.50	805.91	1.27	159.2	0.20
Target Area 1					**Sub area total**	**1590.5**		**234.6**
5512	0.0	-	-	0.0	-	-	0.0	0.00
5612	0.0	-	-	0.0	-	-	0.0	0.00
5712	0.0	-	-	0.0	-	-	0.0	0.00
5812	0.0		-	0.0	-	-	0.0	0.00
Target Area 2b					**Sub area total**	**0.0**		**0.0**
					Grand total	**1590.5**		**234.6**

Table 4. Breakdown of abundance and biomass by survey and sub area (Target area 1: Hebrides, Target area 2: Rockall). Survey 1: North to south, Survey 2: South to north. Blue whiting survey, March-April 2011.

Survey 1	Area	**Abundance (Mils)**			**Biomass ('000s t)**			Mean Length	Mean weight	Density
Target area	nm^s	Immature	Mature	Total	Immature	Mature	Total	(cm)	(g)	t/nmi2
1	33,900	542.1	8515.1	9057.2	21.2	1373.50	1394.7	29.25	129.10	41.14
2b	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0	0	0
Total	33,900.0	542.1	8515.1	9057.2	21.2	1373.5	1394.7			

Survey 2	Area	**Abundance (Mils)**			**Biomass ('000s t)**			Mean Length	Mean weight	Density
Target area	nm^s	Immature	Mature	Total	Immature	Mature	Total	(cm)	(g)	t/nmi2
1	33,900	28.9	1561.6	1590.5	1.0	233.55	234.6	28.05	123.30	6.92
2b	0.00	-	-	0.0	-	-	-	-	-	-
Total	33,900.00	28.88	1561.61	1590.49	1.0	233.6	234.6	28.89	120.65	99.97

Table 5a. Aged stratified estimate of Survey 1 abundance and biomass. Blue whiting survey, March-April 2011.

	Age (yrs) and year class										TSN	TSB	Mn Wt
Length	1	2	3	4	5	6	7	8	9	10			
(cm)	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	(Mils)	('000t)	(g)
13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
15.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
18	50.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.34	1.45	28.8
18.5	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.75	1.22	32.3
19	176.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	176.17	6.22	35.3
19.5	146.8	29.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	176.17	6.52	37.0
20	16.8	8.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.17	1.01	40.0
20.5	37.8	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.50	3.30	43.7
21	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.75	1.76	46.7
21.5	0.0	125.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	125.84	6.62	52.6
22	0.0	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.75	2.30	61.0
22.5	0.0	91.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	91.34	5.55	60.8
23	0.0	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.75	2.39	63.3
23.5	31.8	63.7	31.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	127.38	8.99	70.6
24	0.0	0.0	0.0	27.8	0.0	0.0	0.0	0.0	0.0	0.0	27.83	2.88	103.3
24.5	0.0	28.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.42	2.21	77.7
25	0.0	0.0	25.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.34	2.01	79.5
25.5	6.9	27.5	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.18	3.38	82.2
26	0.0	0.0	22.1	22.1	0.0	0.0	0.0	0.0	0.0	0.0	44.18	3.92	88.7
26.5	0.0	0.0	0.0	50.5	0.0	0.0	0.0	0.0	0.0	0.0	50.51	4.83	95.7
27	0.0	0.0	38.1	9.5	9.5	0.0	0.0	0.0	0.0	0.0	57.11	5.72	100.2
27.5	0.0	0.0	33.1	22.1	11.0	0.0	11.0	0.0	0.0	0.0	77.18	8.30	107.5
28	0.0	0.0	0.0	55.0	0.0	27.5	0.0	0.0	0.0	0.0	82.48	9.00	109.1
28.5	0.0	0.0	78.2	13.0	0.0	26.1	0.0	13.0	0.0	0.0	130.40	15.48	118.7
29	0.0	0.0	23.6	47.1	23.6	47.1	0.0	23.6	0.0	0.0	164.88	20.50	124.3
29.5	0.0	0.0	28.5	28.5	0.0	28.5	0.0	170.9	57.0	28.5	341.81	45.66	133.6
30	0.0	0.0	0.0	18.9	18.9	75.6	151.3	132.4	56.7	0.0	453.79	62.91	138.6
30.5	0.0	0.0	38.5	19.3	19.3	19.3	250.4	154.1	134.8	19.3	654.81	96.23	147.0
31	0.0	0.0	0.0	0.0	0.0	58.5	204.8	351.1	29.3	0.0	643.60	98.59	153.2
31.5	0.0	0.0	0.0	0.0	27.7	55.3	193.7	498.0	249.0	27.7	1051.42	172.16	163.7
32	0.0	0.0	0.0	37.2	0.0	74.4	297.6	223.2	111.6	37.2	781.09	129.95	166.4
32.5	0.0	0.0	0.0	0.0	0.0	55.6	138.9	444.6	305.6	0.0	944.70	165.14	174.8
33	0.0	0.0	0.0	0.0	0.0	25.7	179.6	333.6	77.0	25.7	641.55	116.10	181.0
33.5	0.0	0.0	0.0	0.0	0.0	97.5	97.5	162.4	324.8	0.0	682.18	130.07	190.7
34	0.0	0.0	0.0	0.0	0.0	0.0	19.6	156.5	58.7	39.1	273.82	53.23	194.4
34.5	0.0	0.0	0.0	0.0	0.0	0.0	22.4	89.7	134.5	22.4	268.98	54.73	203.5
35	0.0	0.0	0.0	0.0	0.0	21.2	0.0	21.2	63.7	42.4	148.54	31.86	214.5
35.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	95.6	63.8	31.9	191.25	44.28	231.5
36	0.0	0.0	0.0	0.0	0.0	19.0	0.0	0.0	19.0	38.1	76.17	18.83	247.2
36.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.9	0.0	26.88	6.07	226.0
37	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.5	17.5	0.0	35.04	8.64	246.7
37.5	0.0	0.0	0.0	0.0	0.0	21.7	0.0	0.0	0.0	21.7	43.42	11.20	258.0
38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	10.46	3.03	290.0
38.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	7.1	14.12	4.38	310.0
39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.9	6.9	13.71	4.31	314.7
39.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	10.46	3.58	342.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	10.46	4.09	391.0
40.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	10.46	4.11	393.0
41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
41.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
42.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
44.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
TSN (Mils)	542.1	487.7	326.1	351.0	109.9	653.0	1566.7	2887.3	1754.2	379.2	9057.1	1394.7	
% Mature	0	100	100	100	100	100	100	100	100	100			
TSB ('000t)	21.2	28.9	35.8	41.8	15.0	107.3	255.3	489.5	319.2	80.7	1394.7		
SSB ('000t)		28.9	35.8	41.8	15.0	107.3	255.3	489.5	319.2	80.7	1373.5		
Mn Wt	39.1	65.0	108.5	133.0	149.6	169.3	204.5	199.9	227.1	219.9			
Mn L	18.4	22.2	26.2	28.0	28.9	30.5	31.9	33.2	33.1	32.6			

Table 5b. Aged stratified estimate of Survey 2 abundance and biomass. Blue whiting survey, March-April 2011.

	Age (yrs) and year class										TSN	TSB	Mn Wt
Length	1	2	3	4	5	6	7	8	9	10			
(cm)	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	(Mils)	('000t)	(g)
13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0
15.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0
17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
18.5	5.5	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.12	0.29	32.0
19	15.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.61	0.55	35.0
19.5	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.24	0.12	36.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	41.0
20.5	4.6	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.12	0.39	42.3
21	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.49	0.32	49.5
21.5	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.49	0.33	51.0
22	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.49	0.34	52.0
22.5	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.24	0.20	61.0
23	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.49	0.36	55.5
23.5	0.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.98	0.77	59.5
24	0.0	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.73	0.68	70.3
24.5	0.0	0.0	15.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.61	1.19	76.0
25	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.12	0.74	80.7
25.5	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.71	1.36	81.4
26	0.0	4.8	0.0	4.8	14.5	0.0	0.0	0.0	0.0	0.0	24.20	1.91	79.0
26.5	0.0	0.0	0.0	11.7	0.0	0.0	0.0	0.0	0.0	0.0	11.75	1.12	95.8
27	0.0	0.0	0.0	10.4	5.2	0.0	0.0	0.0	0.0	0.0	15.61	1.51	97.0
27.5	0.0	0.0	0.0	12.1	24.1	0.0	0.0	0.0	0.0	0.0	36.20	3.91	108.1
28	0.0	0.0	17.8	5.9	0.0	5.9	0.0	0.0	0.0	0.0	29.71	3.33	112.1
28.5	0.0	0.0	12.6	12.6	12.6	6.3	12.6	0.0	0.0	0.0	56.58	6.73	119.0
29	0.0	0.0	19.2	19.2	0.0	19.2	0.0	0.0	0.0	0.0	57.62	7.09	123.0
29.5	0.0	0.0	0.0	41.9	0.0	25.2	0.0	16.8	0.0	8.4	92.24	12.21	132.4
30	0.0	0.0	18.9	9.4	9.4	0.0	18.9	47.2	0.0	0.0	103.89	14.14	136.1
30.5	0.0	0.0	5.9	5.9	17.8	47.6	23.8	35.7	0.0	0.0	136.84	19.51	142.6
31	0.0	0.0	0.0	0.0	11.2	11.2	33.6	22.4	44.8	0.0	123.30	18.91	153.4
31.5	0.0	0.0	0.0	10.0	10.0	20.1	20.1	90.4	30.1	0.0	180.71	28.39	157.1
32	0.0	0.0	0.0	0.0	8.1	0.0	0.0	40.7	32.5	0.0	81.36	13.48	165.7
32.5	0.0	0.0	0.0	0.0	0.0	9.6	9.6	106.1	9.6	9.6	144.74	24.90	172.0
33	0.0	0.0	0.0	10.3	0.0	0.0	10.3	72.4	20.7	0.0	113.74	19.87	174.7
33.5	0.0	0.0	0.0	0.0	6.7	0.0	27.0	33.7	20.2	6.7	94.41	17.44	184.7
34	0.0	0.0	0.0	0.0	0.0	6.7	13.5	20.2	20.2	0.0	60.70	11.54	190.1
34.5	0.0	0.0	0.0	0.0	0.0	7.6	0.0	15.1	15.1	7.6	45.44	9.31	204.9
35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	5.5	0.0	11.09	2.31	208.5
35.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	13.0	0.0	21.61	4.68	216.8
36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.9	0.0	6.87	1.57	228.0
36.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5	0.0	2.99	0.69	231.3
37	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	3.73	0.86	231.0
37.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
38.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
39.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	4.73	1.52	321.5
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
40.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
41.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
42.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
43	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
44.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.0
TSN (Mils)	28.9	65.0	115.9	154.5	119.8	159.4	169.4	516.4	228.8	32.4	1590.5	234.6	
% Mature	0	100	100	100	100	100	100	100	100	100			
TSB ('000t)	1.0	3.7	12.6	19.4	15.5	23.3	26.8	85.6	41.2	5.6	234.6		
SSB ('000t)	0	3.7	12.6	19.4	15.5	23.3	26.8	85.6	41.2	5.6	233.5		
Mn Wt	19.4	22.3	27.6	28.9	29.8	31.1	31.6	32.8	34.4	32.5			
Mn L	34.4	55.2	108.9	123.1	134.3	150.7	158.9	176.5	202.8	173.5			

Table 6. Species occurrence from trawl stations. Blue whiting survey, March-April 2011.

Category	Common Name	Scientific Name	Occurrence
Pelagic	Blue Whiting	*Micromesistius poutassou*	11
	Mackerel	*Scomber scombrus*	10
	Horse mackerel	*Trachurus trachurus*	
Mesopelagics	Greater Argentine	*Argentina silus*	
	Hatchet Fish (small)	*Argyropelecus hemigymnus*	1
	Hatchet Fish (large)	*Argyropelecus olfersi*	
	None	*Astronethus gemmifer*	
	Myctophidae	*Benthosema glaciale*	9
	Alfonsino	*Beryx decadactylus*	
	Ray's bream	*Brama brama*	
	Blackfish	*Centrophagus niger*	3
	Sloanes Viper fish	*Chauliodus sloani*	1
	Myctophidae	*Diaphus raffinesqui*	
	Myctophidae	*Diaphus metapoclampus*	
	None	*Diretmus argentus*	
	None	*Echiostoma barbatum*	
	Myctophidae	*Electrona rissoi*	
	Pipefish	*Entelurus aequoreus*	
	Balbo sabretooth	*Evermanella balbo*	
	None	*Gonastoma elongatum*	
	None	*Howella sherborni*	
	None	*Lampadena speculigera*	
	Myctophidae	*Lampanyctus crocodilus*	
	Myctophidae	*Lobianchia gemallari*	
	Searsids	*Maulisia*	
	Pearlside	*Maurolicus muelleri*	1
	Myctophidae	*Myctophum punctatum*	
	Greenland Argentine	*Nansenia groenlandica*	
	Forgotten argentine	*Nansenia oblita*	
	Slender snipe-eel	*Nemichthys scolopaceous*	
	Multipore Searside	*Normichthys operosus*	
	None	*Notolepis rissoi*	4
	Myctophidae	*Notoscopelus krokeyeri*	
	None	*Opisthoproctus soleatus*	
	Shrimps	*Pandalidae*	
	Silver Pomfret	*Pterycombus brama*	
	Schnakenbeck's searside	*Sagamichthys schnakenbecki*	
	None	*Scopelosaurus lepidus*	
	None	*Searsia koefoedi*	
	Bean's sawtoothed eel	*Serrivomer beani*	
	None	*Sternoptyx diaphana*	
	Scaly dragonfish	*Stomias boa*	1
	Myctophidae	*Symbolophoros veranyi*	
	Greater Pipefish	*Syngnathus acus*	
	Dealfish	*Trachipterus arcticus*	
	Bluntsnout smooth-head	*Xenodermichthys copei*	
Demersal	Grey Gurnard	*Eutrigla gurnardus*	1
	Silvery Pout	*Gadiculus argentus*	
	Norway Pout		
	Hake	*Merluccius merluccius*	2
	Anglerfish	*Lophius piscatorius*	
	Saithe	*Pollachius virens*	
Squid	Lesser flying squid	*Todaropsis elbanae*	2
	Northern flying squid	*Todarodes sagittatus*	2
	Short finned squid	*Omnastrephidae*	
	European flying squid	Todorodes sagittatus	
Other	Jellyfish		
	Octopus		
		Total Number of Trawls	**11**
		Total number of Species:	**13**

Table 7. Irish survey time series. Blue whiting survey, March-April 2011.

Year	2004	2005	2006	2007	2008	2009	2010	2011	2011
Target areas	2a 2b,2c	1 2a,2b	2b	1 2a,2b	1 2a,2b	1 2b	1 2b	Survey 1 1, 2b	Survey 2 1, 2b
Age									
1	2.98	37.35	4.37	2.4	13.9	2.2	2.5	21.2	1.0
2	108.26	64.04	43.22	31	12.5	66.7	1.5	28.9	3.7
3	346.43	500.0	242.45	585	128.7	49.9	3.3	35.8	12.6
4	524.02	911.1	636.69	1681	1148.0	236.3	8.6	41.8	19.4
5	211.5	1010.0	342.56	1424	1445.7	1126.8	15.0	15.0	15.5
6	154.51	311.0	144.7	639.2	762.9	1444.3	81.7	107.3	23.3
7	72.76	111.0	50.41	219.3	200.0	563.6	143.3	255.3	26.8
8	34.71	69.9	18.02	126.2	33.1	117.6	104.2	489.5	85.6
9	4.06	20.5	0	14.6	0	31.4	19.2	319.2	41.2
10+	15.61	7.87	0	5.4	0	12.9	5.6	80.7	5.6
TSB ('000t)	1,474.9	3,044.0	1,482.4	4,727.6	3,744.7	3,651.7	385.0	1,394.7	234.6
TSN (mils)	16,029.3	34,268.0	16,344.0	48,746.1	34,179.6	28,512.2	2,365.3	9,057.1	1,590.5
SSB ('000t)	1,471.9	3,001.0	1,478.1	4,725.2	3,726.4	3,647.9	382.6	1,373.5	233.6

Target area 1: Hebrides & north Porcupine Bank; Target area 2a: western Porcupine Bank; Target area 2b: Rockall

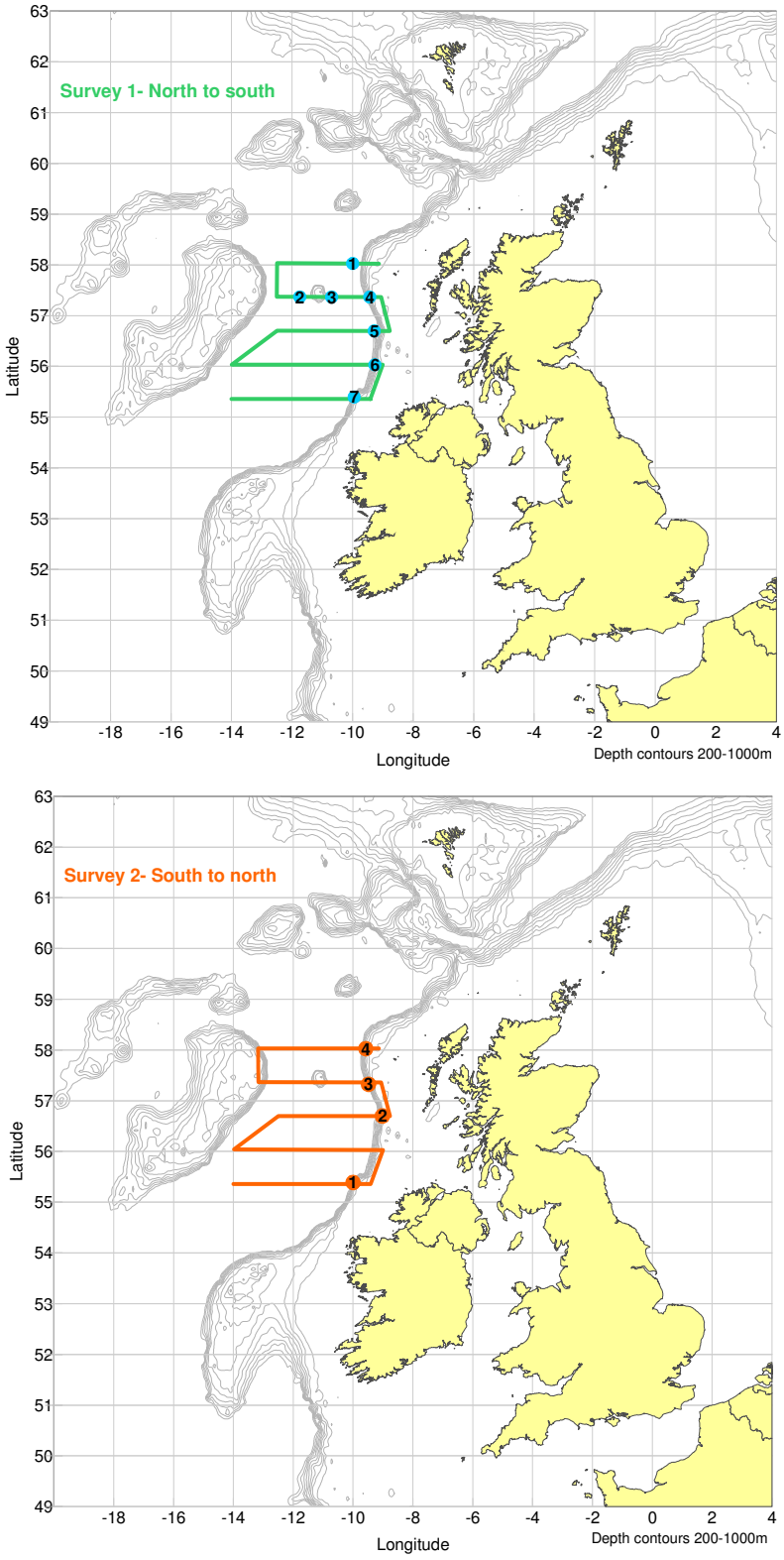


Figure 1. RV Celtic Explorer cruise tracks and trawl positions for Survey 1 (top) & Survey 2 (bottom). Blue whiting survey, March-April 2011.

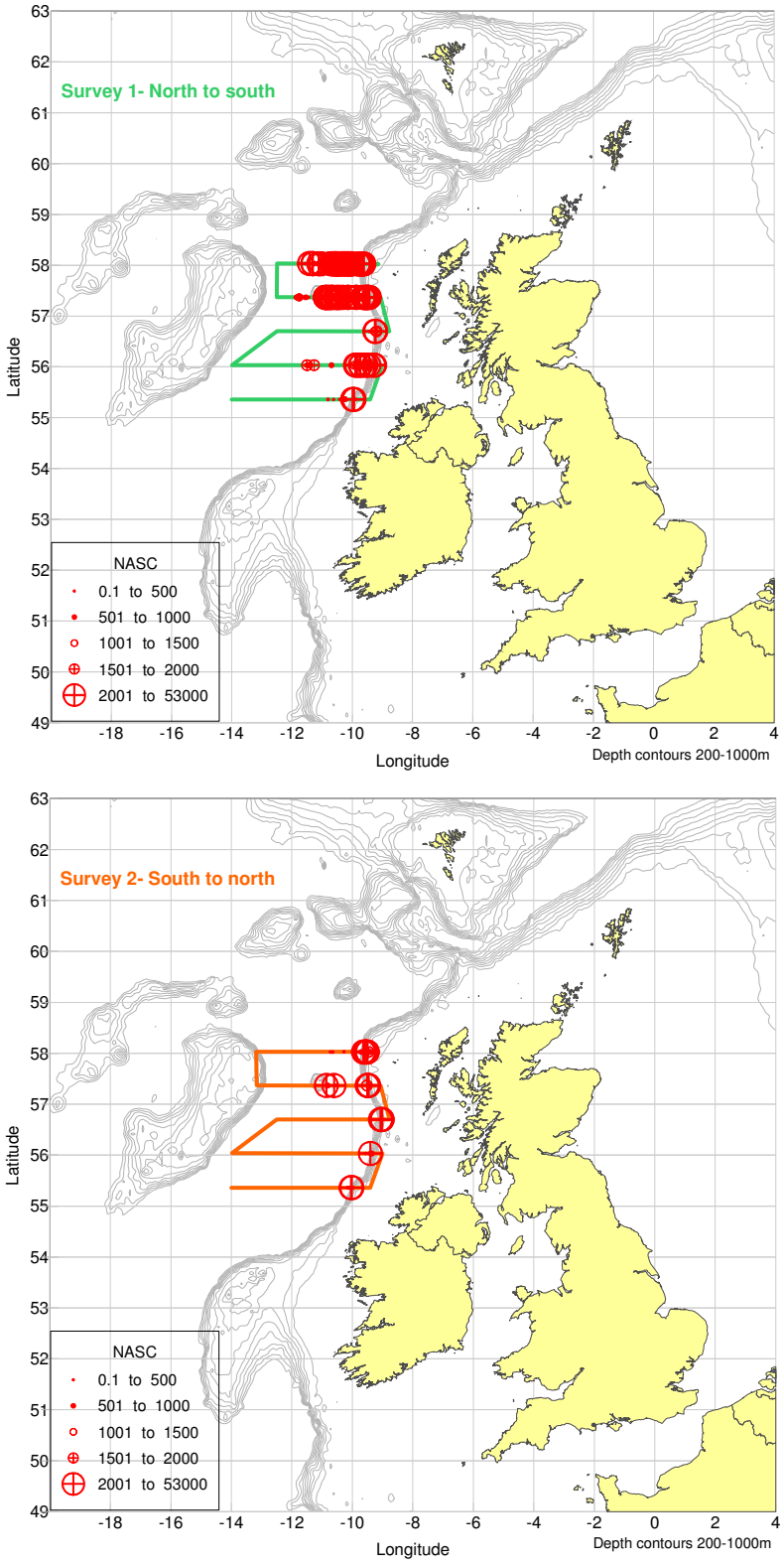
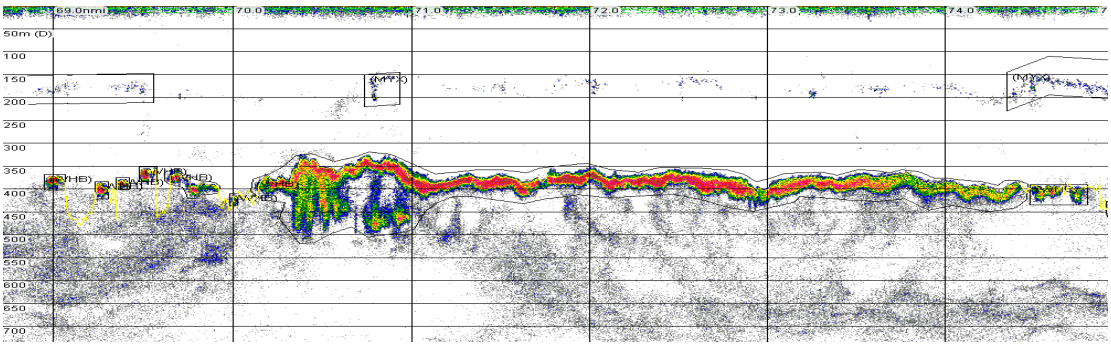
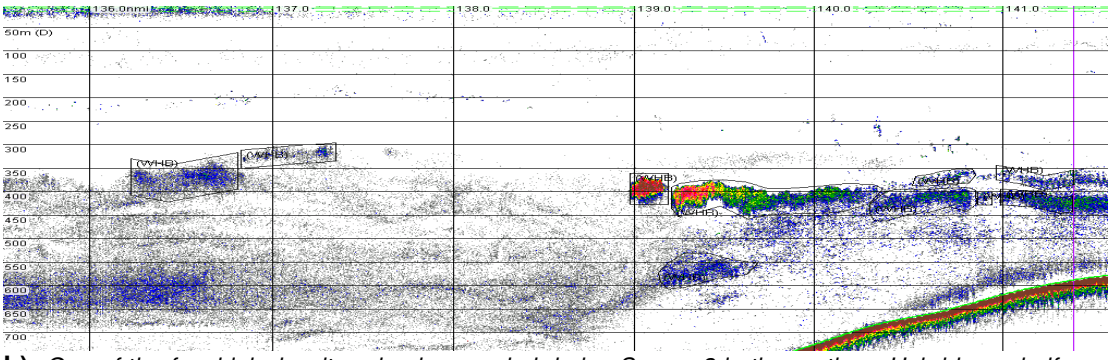


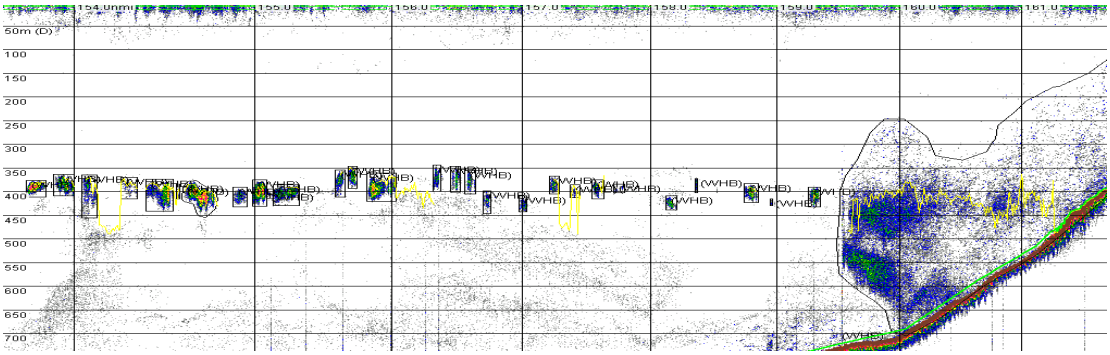
Figure 2. NASC distribution plot of blue whiting occurrence by survey. Blue whiting survey, March-April 2011.



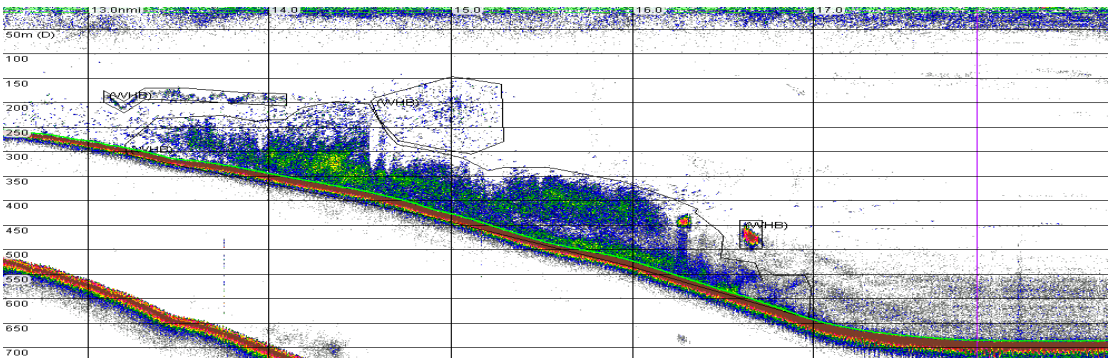
a). *Single highest density school of blue whiting recorded during the survey. Recorded during Survey 1 in the northern area along the Hebridean shel at 57.5ºN.*



b). *One of the few high density schools recorded during Survey 2 in the northern Hebridean shelf area at 58ºN.*



c). *Medium to high density schools of blue whiting observed on the southern Hebridean shelf area during Survey 1 at 56ºN.*



d). *Medium to high density schools of blue whiting observed on the southern Hebridean shelf area during Survey 2 at 56ºN.*

Figures 3a-d. Echotraces recorded on the ER60 echosounder with images captured from Echoview during the blue whiting survey, March-April 2011. Note: Vertical bands on echogram represent 1nmi (nautical mile) intervals. Depth scale (m) shown on left of image.

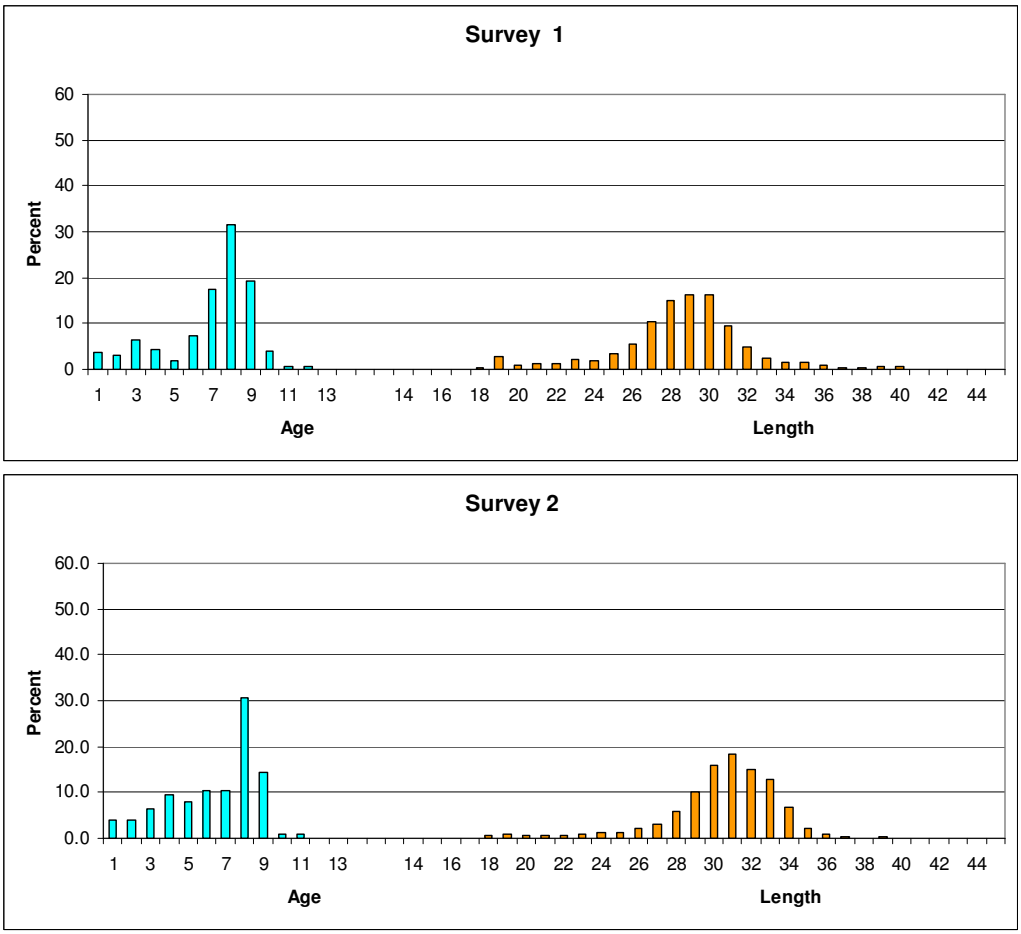


Figure 4. Combined age (left) and length (right) composition by survey replicate. Survey 1: north to south, Survey 2: south to north. Blue whiting survey, March-April 2011.

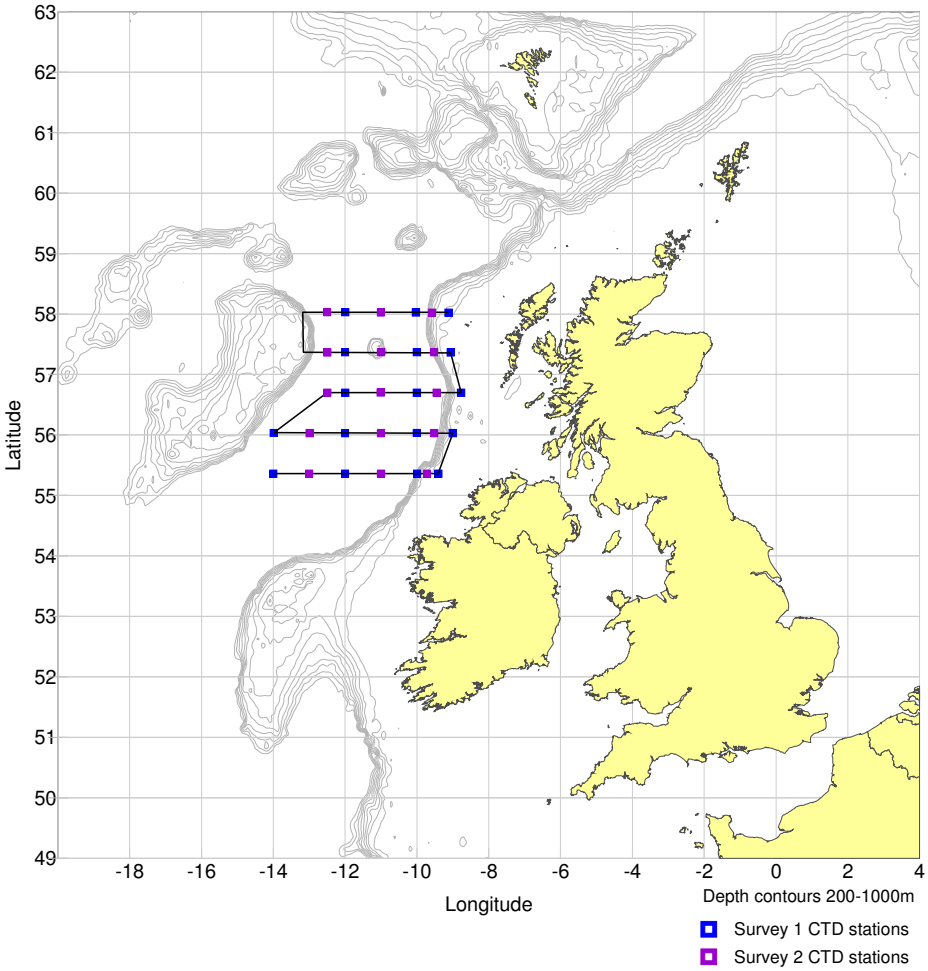


Figure 5. Position of hydrographic stations. Note: Open water stations were carried out to a maximum depth of 1000m. Blue whiting survey, March-April 2011.

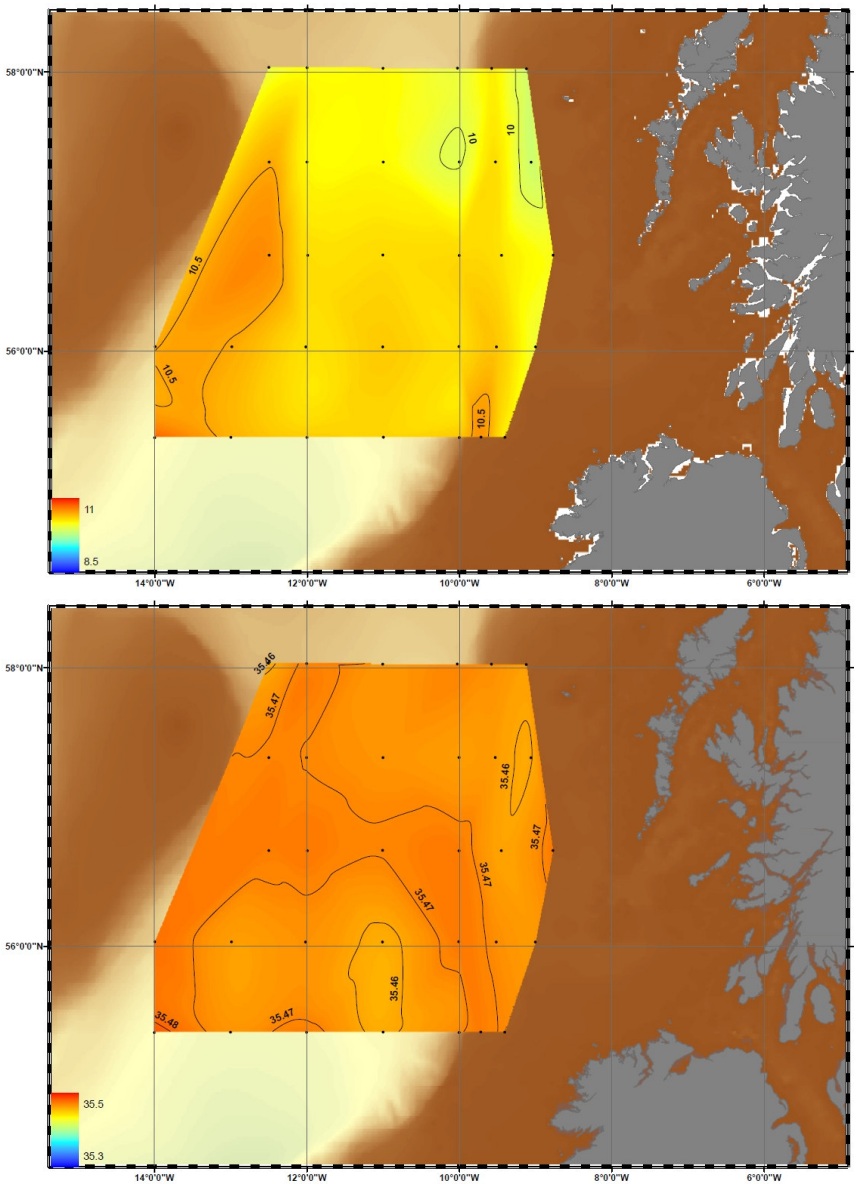


Figure 6. Horizontal temperature (top panel) and salinity (bottom panel) at 10m as derived from vertical CTD cast data. Blue whiting survey, March-April 2011.

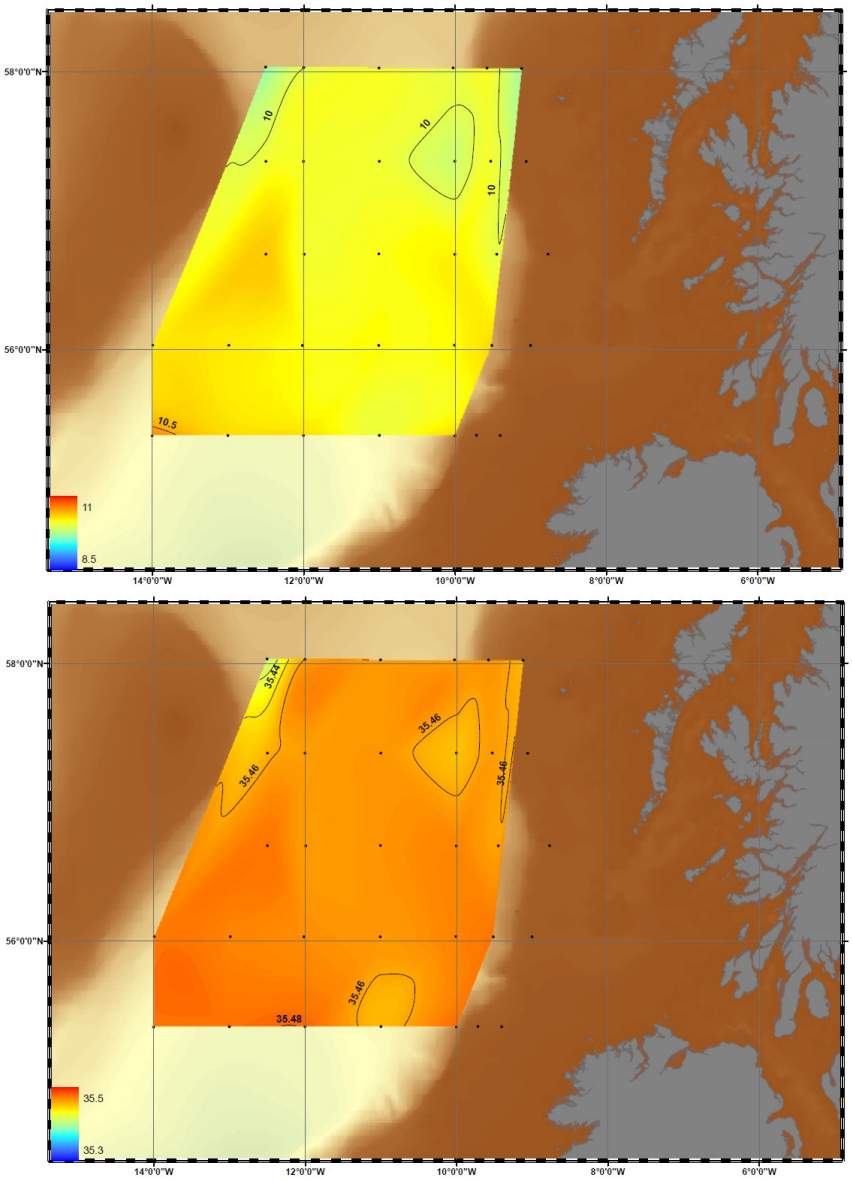


Figure 7. Horizontal temperature (top panel) and salinity (bottom panel) at 200m as derived from vertical CTD cast data. Blue whiting survey, March-April 2011.

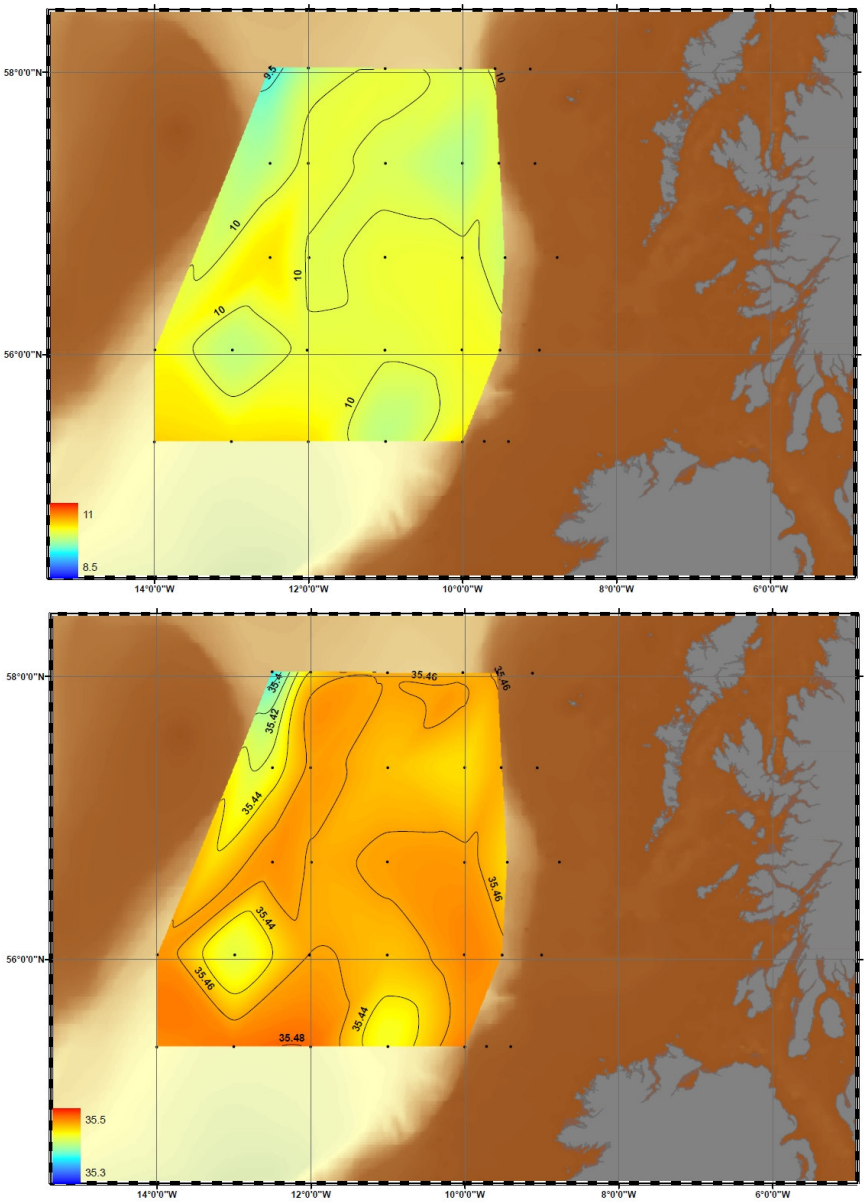


Figure 8. Horizontal distribution of temperature (top) and salinity (bottom) at 400m as derived from vertical CTD cast data. Blue whiting survey, March-April 2011.

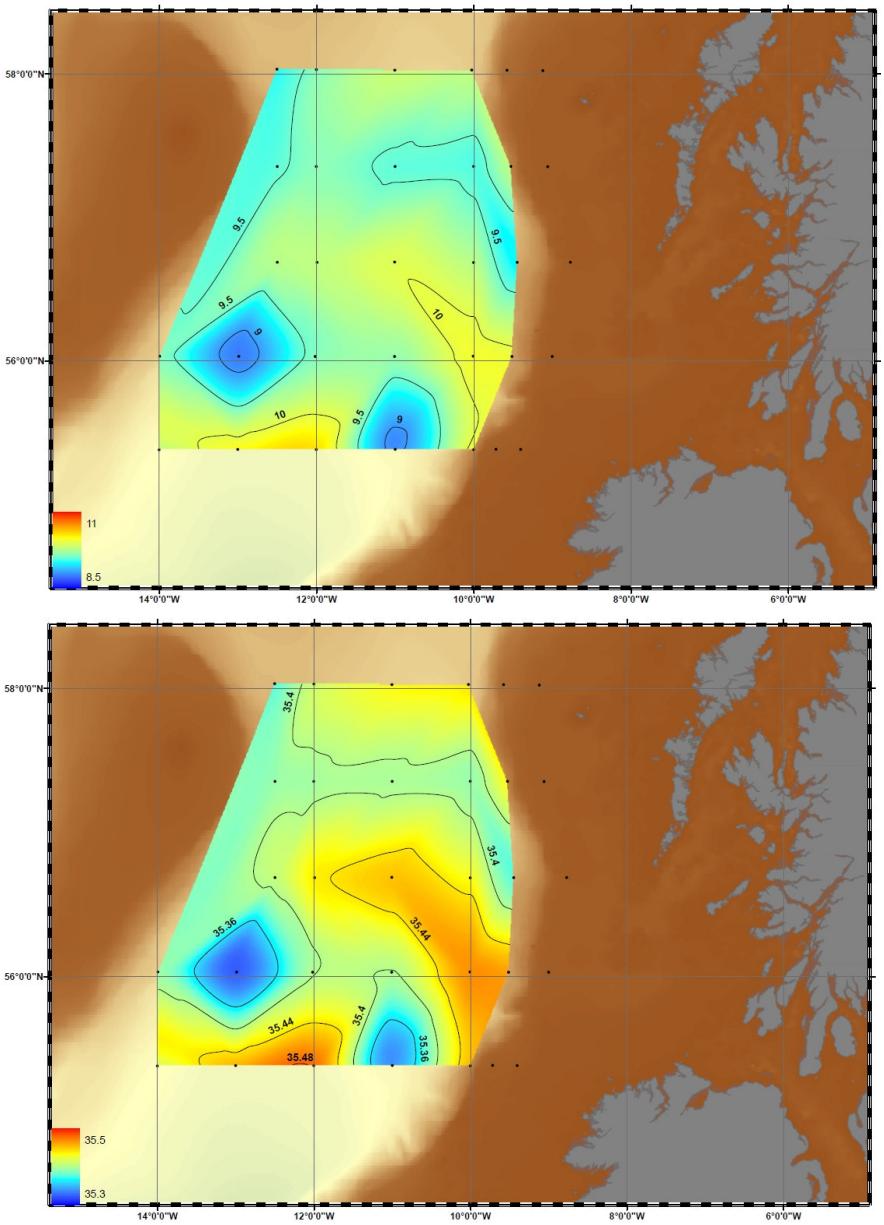
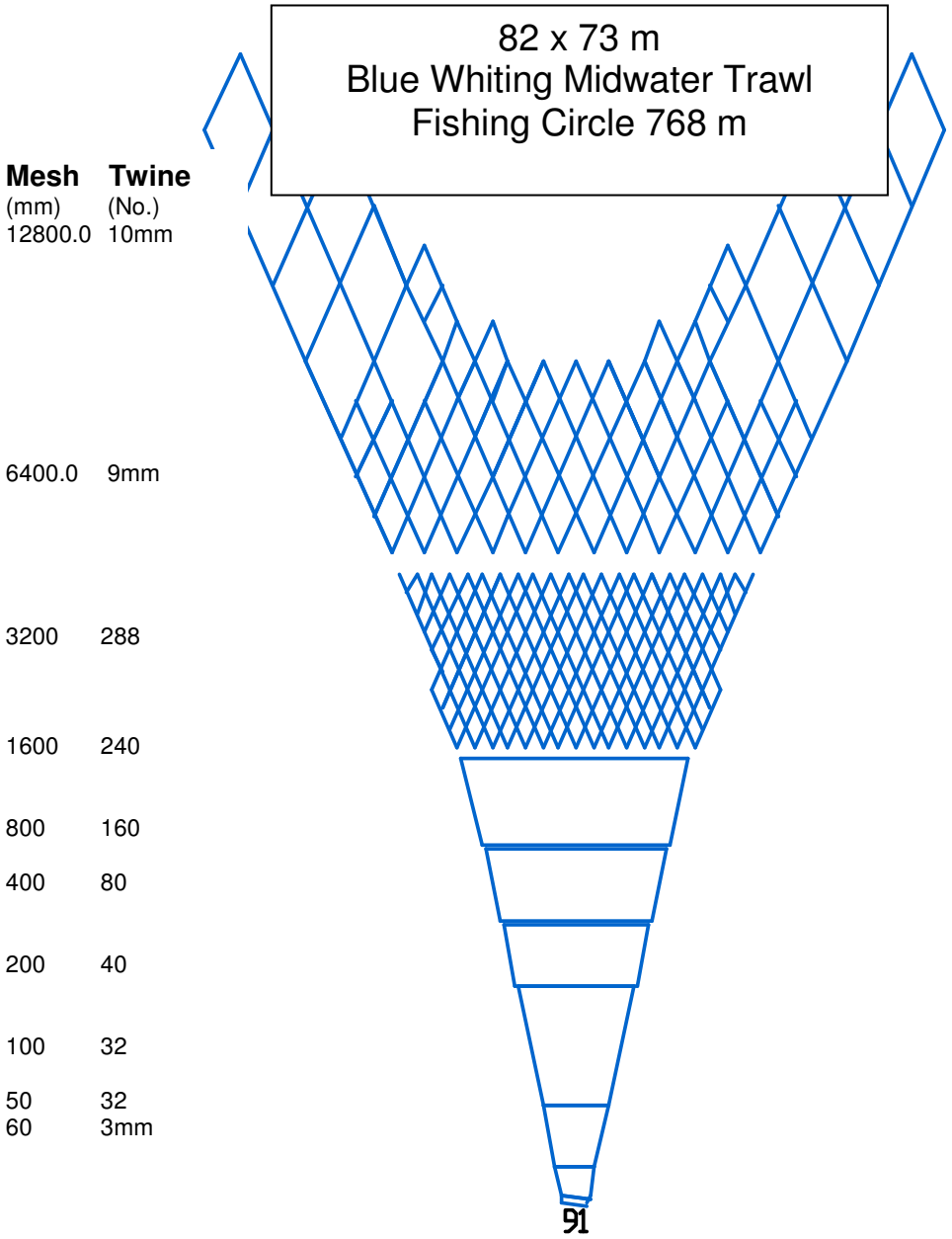


Figure 9. Horizontal distribution of temperature (top) and salinity (bottom) at 600m as derived from vertical CTD cast data. Blue whiting survey, March-April 2011.



Net specifics	
Clump weights:	1000 Kg per side
Trawl doors:	Polyice pelagic 6m² (750Kg weight in air)
Bridle length:	80m
Door spread:	170m
Vertical net opening:	50m

Figure 10. Pelagic midwater trawl employed during the Blue whiting Acoustic Survey, March-April 2011.